U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 120.

THE PRINCIPAL INSECTS AFFECTING THE TOBACCO PLANT.

BY

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[Reprinted, with slight revision by the author, from the Yearbook of the Department of Agriculture for 1898.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1900.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,
Washington, D. C., July 18, 1900.

SIR: I have the honor to transmit herewith a copy of an article contributed by me to the Yearbook for 1898, entitled "The Principal Insects Affecting the Tobacco Plant." I have made some slight changes in it, so as to bring the matters treated up to date, and recommend that it be republished as a Farmers' Bulletin.

Respectfully,

L. O. HOWARD, *Entomologist.*

Hon. JAMES WILSON, *Secretary of Agriculture.*

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THE PRINCIPAL INSECTS AFFECTING THE TOBACCO PLANT.

INTRODUCTION.

The tobacco plant, although indigenous to America, does not suffer so greatly from the attacks of insects in the United States as do others of our crop plants. It has no insect enemies peculiar to itself, but every season a certain amount of damage is done by insects, and in some years favorable to insect increase this damage may mean a serious loss to the planter.

The most comprehensive work upon tobacco insects which has been published is in the Italian language, and includes a consideration of all species which affect this crop, both in the field and in the factory. But this work treats largely of European insects, being a special report of the entomological agricultural experiment station at Florence, entitled "Animals and insects of growing and dried tobacco," by Prof. A. Targioni-Tozzetti. In this country there have been occasional accounts of specific insects in the different agricultural reports and in the bulletins of the State experiment stations. Prof. H. Garman, of the Kentucky experiment station, in particular, has given the subject much attention, and has done admirable work in the important direction of proving the possibility of the practical use of arsenical mixtures on the tobacco plant. The most comprehensive article which has yet been prepared in this country is one printed by the Florida Agricultural Experiment Station as Bulletin No. 48, with the title "A preliminary report upon the insect enemies of tobacco in Florida," by A. L. Quaintance.

The present paper contains accounts of several tobacco insects not included in the bulletin by the Florida author, who, as the title indicates, treats only of the species occurring in Florida, but the writer defers to Professor Quaintance in matters of actual field experience concerning several of the species, and wishes here to express his thanks for advance proof sheets of the bulletin in question, which have enabled him to make this paper more complete than it would otherwise have been.

From the time when the seed is sown in the seed bed to the time when the tobacco field is plowed under to some late fall crop, the

tobacco plant is subject to the attacks of several species of insects. Throughout the tobacco-growing regions of the United States there is probably no one insect which does more damage to the marketed product than the tobacco flea-beetle, or "flea bug," as it is commonly known to growers (*Epitrix parvula*). The large horn worms or "horn-blowers," also insects of wide distribution, tobacco growers must always fight. The bud worm, which may be either the larva of *Heliothis rhexia* or of the cotton boll worm or tomato fruit worm or corn-ear worm, as it is called according as it affects different plants (larva of *Heliothis armiger*), attacks and bores into the central leaf roll or "bud" early in the summer, or later in the season into the seed pods or into the terminal flower stalk, and even feeds to a certain extent upon the leaves. Several species of cutworms are liable to occasion replanting in soil which has not been properly treated, and one or two of them rag the leaves late in the season. Certain wireworms also are liable to affect the young plant shortly after it is set out. Two or more species of plant bugs occasionally damage the leaves by inserting their beaks and sucking the juices, causing a drying and shriveling of the leaf in much the same way as the harlequin cabbage bug injures the leaves of cabbage. One of these plant bugs, a small species, insignificant in appearance, has recently proved to be a serious enemy to tobacco culture in Florida. Another new insect, and one which may prove to be a very important factor in tobacco culture, is the so-called tobacco leaf-miner, or "split worm," an insect which although first found in North Carolina only two years ago has since made its appearance in Florida, South Carolina, and southern Virginia. These comprise the principal species damaging growing tobacco at the present time. There is always a chance, however, that new insect enemies may make their appearance just as two of those above mentioned have done in very recent times, and it is safe to say that many of the species which affect solanaceous plants, and especially the tomato, are liable to transfer their attentions to the tobacco crop under favorable conditions.

After the tobacco has reached the factory, an insect enemy of importance, and which is always to be feared, is the cigarette beetle (*Lasioderma serricorne*), a species which riddles the tobacco leaf, which bores into or out of manufactured cigarettes and cigars, and which, when once introduced into a not over cleanly factory, is very difficult to eradicate. Two or three other little beetles have been found in dried tobacco, namely, the drug-store beetle (*Sitodrepa panicea*) and the rice weevil (*Calandra oryza*), but they are not as important as the cigarette beetle.

It is proposed to give in this bulletin a short account of these insects and other species of less importance, with some indication of the proper remedies under each, and a concluding paragraph on remedial work as a whole.

THE TOBACCO FLEA-BEETLE.

(*Epitrix parvula* Fabr.)

This active little insect (fig. 1) may be found in almost any tobacco field from Arkansas to Florida and north to Connecticut. It is a minute, oval, reddish-brown species, which occurs upon many solanaceous plants, feeding upon tomato, potato, horse nettle, and jimson weed (*Datura stramonium*). The beetles make their appearance in July, attacking first the lower and then the upper leaves. After they have fed for awhile the leaf becomes full of small, dry spots and then of holes about the size of a pin point, which later may become considerably enlarged (fig. 2). When the crop is cured it is poor and thin, and frequently full of small holes. While the main damage is done in the beetle condition, the insect feeds also, in its early stages, upon the tobacco. Its eggs being laid at the roots, hatch into minute, whitish larvæ, which feed upon the roots, and, in the course of about a month, as ascertained by Mr. Chittenden, reach full growth, transform to pupæ, and again to adult beetles. The damage done to the roots in this way must affect the health of the plant to a certain extent, but it is not appreciable in comparison with the damage which the adult beetles do to the leaves. The insect, in its early stages, is not confined to tobacco, but feeds also upon the nightshade and the jimson weed, as also ascertained by Mr. Chittenden.

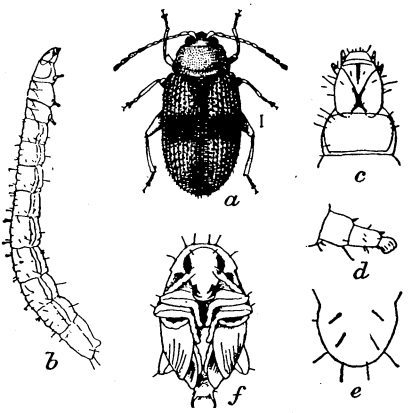

FIG. 1.—*Epitrix parvula: a*, adult beetle; *b*, larva, lateral view; *c*, head of larva; *d*, posterior leg of same; *e*, anal segment, dorsal view; *f*, pupa—*a*, *b*, *f* enlarged about fifteen times, *c*, *d*, *e* more enlarged (after Chittenden).

It is not alone in the actual damage to the leaves done by the jaws of the beetle that this insect is injurious to the foliage of tobacco, but through the further fact that these little holes, even when the puncture is not through the entire thickness of the leaf, become the entrance points of fungous spores or bacteria, which start a disease of the leaf which frequently damages it much more than the insects themselves. In moist weather this disease, started by the flea-beetles, may do considerable damage when the flea-beetles themselves are comparatively scarce.

By some writers the round white spots in the leaves, which are illustrated in fig. 3, have been considered to result from the initial work of the tobacco flea-beetle; but, as reported by several workers upon fungous diseases, these spots have been shown to be invaded by

a species of fungus belonging to the genus Cercospora, members of which actually cause leaf diseases upon other plants, and which are certainly capable of damaging leaves in this way without the preliminary insect work. The commonest form of this damage seems to be caused by *Cercospora nicotinæ*, and is known as "frog eye" or "white speck." Another similar disease known by the same names occurs in Florida, and another in Europe, where it is known as "smallpox." The "white speck" of the North Carolina planters is said by Ellis and Everhart to be caused by a fungus known as *Macrosporium tabacinum*. Although not proved, it is quite possible that the tobacco flea-beetle is more or less responsible for, if not the occurrence, at least the spread of these diseases. There is a fad for cigar wrappers spotted in this way. A patent on an artificial method of imitating these disease spots has lately been issued.

FIG. 2.—Tobacco leaves damaged by *Epitrix parvula* (original).

The writer has visited tobacco fields in Virginia in which almost every plant was more or less affected by the tobacco flea-beetle. The upper leaves were spotted by their work, particularly near the edges, and the lower leaves were riddled with holes and almost covered with the white fungous spots.

REMEDIES.

Reference will be made later in this bulletin to the advantage of clean cultivation in the tobacco fields. The destruction of weeds, particularly solanaceous weeds, along the margins of the field, will be of positive benefit in reducing the numbers of this insect, as well as other tobacco insects, unless (and this suggestion we make as one of much possible value) it shall be found feasible to grow a few clumps of nightshade or jimson weed as trap crops for the beetles, the plants to be thoroughly poisoned in the early summer before the tobacco has been set out. The tobacco crop is one of a few which are peculiarly adapted to this kind of remedial treatment. In the ordinary course of tobacco culture the weeds are allowed to grow freely about the margins of the fields. Before the tobacco plants are set out, those

weeds which are secondary food plants of tobacco insects, such as *Solanum nigrum*, *Solanum carolinense*, and *Datura stramonium*, act simply as concentrators and multipliers of the tobacco insects, so that the insects are already in force about the margins of the fields, ready to transfer their attentions to the young and succulent tobacco plants after they have been planted. From this it is plain that, if the margins of the fields are kept free from such plants, the insects will not have as good a start, and will not be present in such great numbers. It also follows that, if a few attractive weeds are left in clumps, the flea-beetles and other tobacco insects of the immediate vicinity will concentrate upon these few weeds, where they can readily be killed, either by the application of an arsenical poison, if they are gnawing insects, or of a kerosene emulsion, if they are sucking insects.

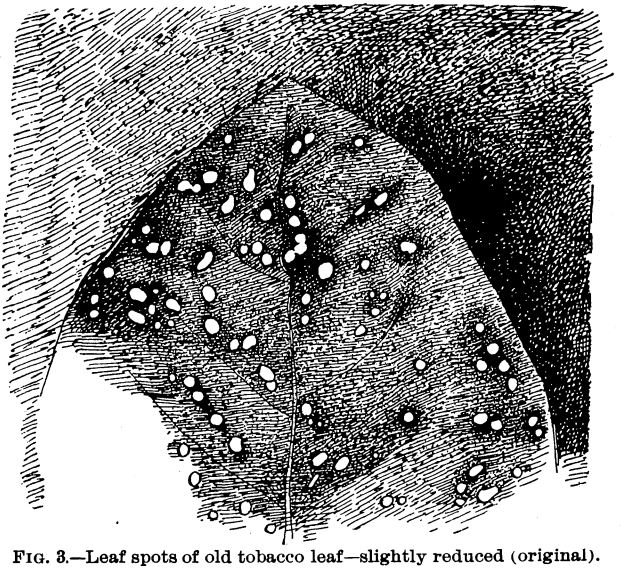

FIG. 3.—Leaf spots of old tobacco leaf—slightly reduced (original).

Where preliminary work of this nature has been neglected, and it becomes necessary to treat the tobacco flea-beetle in the tobacco field, we are prepared to heartily recommend the use of arsenical poisons. Small as the insect is, and much as its initial work looks like the puncture of a beak rather than the nibbling of a pair of jaws, it is a true biting or gnawing insect; therefore, if the leaves be treated, even with a minute quantity of an arsenical poison, the insect will be reached by it in the act of eating the leaf, and will be destroyed. This is not as satisfactory a means of killing the insect as the preventive mentioned above, for the reason that, in order to get its dose of the poison, the insect must damage the leaf to a certain extent, and as there is a constant succession of new beetles, the leaves will become damaged more or less, even though the insects be destroyed;

still, it prevents any great damage, and insects thus poisoned are out of the way for good, both as regards future damage by the individual and by its otherwise possible offspring.

When the idea of poisoning the tobacco leaf was first suggested it met with considerable opposition. It was feared that the persistence of the poison might render the tobacco dangerous to the human consumer. This fear still exists in many quarters; in fact, the average smoker, and, still more, the average chewer, would hardly fancy the

FIG. 4.—Northern tobacco worm, or "horn worm" (*Protoparce celeus*): *a*, adult moth; *b*, full-grown larva; *c*, pupa—natural size (original).

idea that his tobacco had, at any time, been treated with arsenic. The same feeling, however, existed when Paris green was first used on the potato crop for the Colorado potato beetle. It was expressed when fruit growers began to spray apple trees for the codling moth, and it still remains in regard to the use of arsenicals upon cabbages, in spite of the fact that most cabbage growers are using them, and that it has been repeatedly shown that the quantity of poison which is effective is so infinitesimally small that not the least possible harm can result to the consumer. The same holds with regard to tobacco.

Careful experimentation by Professor Garman in Kentucky and the experience of practical tobacco growers in Kentucky and South Carolina have shown that, properly used, no possible harm can result from the application of an arsenical poison. Summarizing from the practical experience on record, it is the opinion of the writer that Paris green, in the proportion of 1 pound to 125 gallons of water, is the proper mixture to apply to tobacco plants. Used at this strength, it will not kill all of the flea-beetles, but it will greatly reduce their numbers. It will also be efficacious at this strength against the young caterpillars of the horn worm, or hornblower, and against sun-

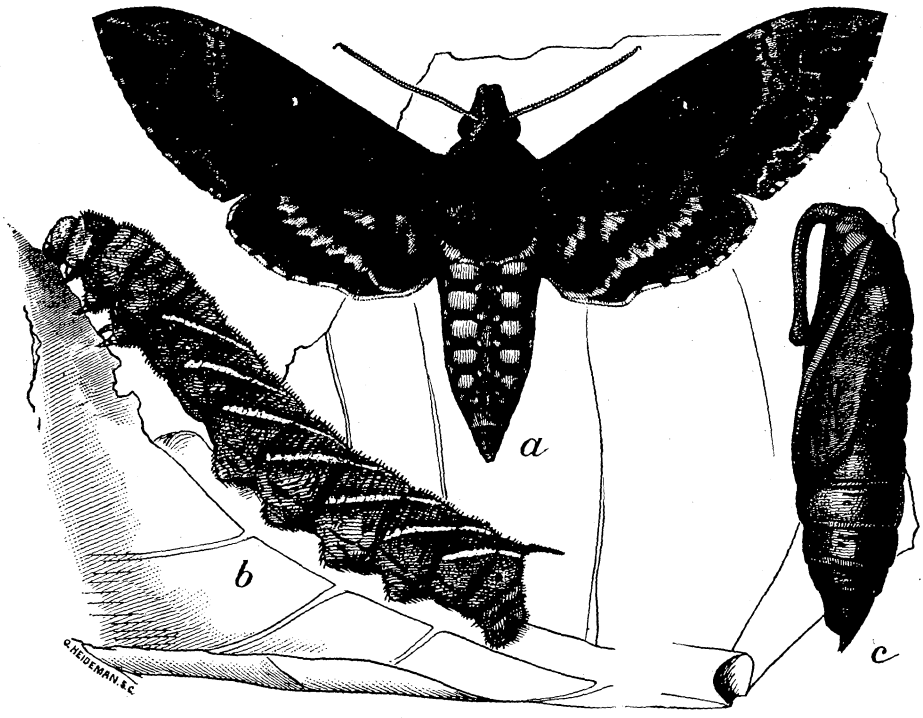

FIG. 5.—Southern tobacco worm (*Protoparce carolina*): *a*, adult moth; *b*, full-grown larva; *c*, pupa—natural size (original).

dry other tobacco insects, as will later be shown. In the dry state, it may be mixed with twenty parts of spoiled flour or any fine dust, such as road dust, and dusted on the plants from one of the machines known as powder guns, or from a coarse cloth bag or sack.

After the available portions of the plants are cut in the fall, and the planter is ready to plow his fields to small grain or some other crop, there will be a positive advantage in treating the portions of the plants left in the field with a considerably stronger arsenical mixture. This, in the warm days of autumn, will kill the insects remaining in the fields, many of which would otherwise have successfully hibernated and put in an appearance ready for destructive work the

following season. The writer was particularly struck with this point the first week in November in southern Virginia. The tobacco crop had been entirely harvested, but no killing frosts had occurred. The days were warm and sunny and the nights cold. On the remaining portions of the tobacco plants in the fields were many flea-beetles, bud worms, and cutworms, which, a week or so later, would have entered hibernating quarters. Just at this time, with a slight expenditure of energy, the useless remnants of the tobacco plants could have been poisoned, and practically all of these insects destroyed, much to the advantage of next year's crop.

THE TOBACCO HORN WORMS, OR HORNBLOWERS.

(*Protoparce carolina* Linn. and *Protoparce celeus* Hübn.)

There are two species of large sphinx moths whose larvæ, or caterpillars, eat the leaves of tobacco, tomato, and allied plants, including, occasionally, the Irish potato. These caterpillars, from the fact that each bears upon one of the posterior segments of its body a rather stout, curved horn, have become popularly known as horn worms. This term "horn worm" has, in some incomprehensible way, been corrupted into "hornblower" in Maryland and Virginia, where it is applied to the adult moth.

FIG. 6.—Southern tobacco worm dead and shriveled from bacterial disease—natural size (original).

Tobacco growers do not distinguish between the two different kinds of horn worms, and for practical purposes it is not in the least necessary that they should distinguish them. As a matter of general interest, however, it may be stated that the horn on the end of the body of *carolina* is red, while that of *celeus* is black. Both are green in color, with oblique white stripes on the sides of the body. These white stripes extend farther up on the back with the caterpillar of *carolina* than they do with the caterpillar of *celeus*. The curious brown pupa into which the caterpillar transforms, which is found under the surface of the ground, and which is at once recognized by the handle-shaped process which issues from the top of the head, is distinguished in the two species by the fact that the handle-shaped process, which is really the tongue case, is much longer with the pupa of *celeus* than it is with the pupa of *carolina*.[1] From these pupæ, or chrysalids, issue the adult moths. The moths of the two species may be distinguished from the fact that *carolina* is darker, and the orange spots along the sides of the body are more vivid, while the center of the hind wings of *celeus* bears two distinct, zigzag lines, which in *carolina* become blurred, darkened, and indistinct. All of these points are plainly brought out in figs. 4 and 5.

[1] The figures of both Harris and Glover are misleading on this point.

Both of these insects occur more or less abundantly in the tobacco fields over the entire tobacco-growing regions of the United States. In certain localities one species will be much more abundant than the other, and in other localities the numbers will be more evenly divided. In general, it may be said that *celeus* is the more northern species, and is found more abundantly in the more northern tobacco fields, while farther south *carolina* is apt to be much the more common. In the tobacco-growing regions of Connecticut, for example, according to Professor Fernald, *celeus* is the more common tobacco worm, while in Florida the reverse condition holds. Both species occur from Canada to Florida, and as the region of tobacco culture fails in the North, both species feed upon tomato. *Carolina* extends its range into the West Indies and South America, but *celeus* is not found south of Florida.

The life histories of both species are practically identical. Varying in date, according to the climate, the moths make their appearance, working their way out of the underground pupæ, or chrysalids, from May 1 well on into June, pair, and lay their eggs singly on the undersides of the leaves. The young caterpillars hatch from these eggs, which, by the way, are laid in the dusk of the evening, in from four to eight days, according to Professor Alwood's observation of *carolina*. In the course of their growth they cast their skin four times, and in less than a month become full grown, burrow into the soil, and transform to pupæ.

The number of generations in a year varies in different localities. In the greater part of the tobacco-growing region planters have recognized that there are two "crops" of the worms. This holds in portions of Maryland. At Blacksburg, Va., Professor Alwood has found that one "crop" is normal, and that there are occasional indications of a second "crop," or generation. In Florida, where the moths make their appearance early in May, according to Professor Quaintance, the first generation of caterpillars is not particularly destructive, but the second generation, which appears during July, causes the most damage. A third generation is normal, and probably a fourth, although in July caterpillars of various sizes may be found in the fields at one time. The retardation of development in some individuals, and acceleration in others, bring about an intermingling of generations, which is always marked in insects in the South where the number of generations exceeds three. In Cuba, where the *carolina* horn worm is said to be a severe pest to the tobacco industry, there is probably an even larger number of generations.

Actual damage done by horn worms varies greatly in different seasons. Frequently, for a number of years, they will not be too abundant to be kept down readily by hand picking, and then will come a season in which they are so numerous that it is very difficult to save the crop without incurring a prohibitive expense. Again,

comparative immunity during one summer will be followed by considerable damage the next. Professor Garman, in Bulletin No. 66 of the Kentucky Agricultural Experiment Station, states that the summer of 1896 was one of extraordinary abundance. The horn worms "were present on both tobacco and tomato in myriads, and proved so destructive that some fields of tobacco were abandoned and in the fall presented only a wilderness of stems and midribs of leaves. In such fields as many as five worms, representing both species, were frequently observed on a single plant. Their advent was so sudden that before the seriousness of the outbreak was realized tobacco that had been the pride of the owner and showed scarcely a mutilated leaf was severely injured. It was near cutting time when they became most abundant, and some growers preferred to cut their tobacco as the best means of saving it. On suckers in fields and on abandoned tobacco the worms remained until frosts killed the plants. Large numbers of both species were collected in October from such tobacco, and they were observed in fields until October 12."

Both kinds of horn worms are extremely subject to disease and to the attacks of natural enemies. Caterpillars which are observed to turn dark in color are attacked by a bacterial disease, which invariably results in their death (fig. 6). Certain parasitic insects attack others, and all tobacco growers are familiar with the appearance of a horn worm partly or entirely covered with little, white, oval cocoons. Such specimens should not be crushed, since the cocoons are made by one of the most important of the parasites of these larvæ, which, if allowed to emerge undisturbed, will increase the mortality among the caterpillars. Others may occasionally be noticed bearing very minute, oval, white eggs sticking closely to the skin. These are the eggs of a Tachina fly, and the maggots which hatch from these eggs bore into the caterpillar and eventually destroy it.

REMEDIES.

It will be unnecessary to repeat what has been said under the head of "The tobacco flea-beetle" concerning the use of arsenical poisons. When the first generation of horn worms appears (and each tobacco grower must determine the approximate date from observation in his own fields), an application of Paris green, either dry or in the liquid form, as elsewhere described, is by far the best remedy when the insects are numerous. In ordinary seasons and in certain localities the tobacco crop will not suffer so severely that it can not be protected by the ordinary process of hand picking, or "worming," as it is called. Most conservative tobacco planters send their hands through the fields to pick off the caterpillars and crush them, and rely upon no other remedial work.

The adult moth possesses a long beak, through which it sucks the nectar of flowers, being attracted especially to the sweetest flowers

and those possessing a long, tubular corolla, like the honeysuckle and the morning-glory and the flower of the Jamestown, or "jimson" weed. Many years ago it occurred to an observing planter that the jimson-weed flowers might be poisoned to advantage, and from this suggestion has grown up the custom in certain parts of the country of squirting into the flowers of the jimson weeds growing in the immediate vicinity of the tobacco fields a certain amount of sweetened water poisoned with cobalt or "fly stone." A modification of this process, described by Professor Quaintance, is as follows: "In the evening a quantity of the bloom of the jimson weed is procured and is placed promiscuously through the field under holes in horizontal slats, supported by sticks or otherwise, and into the flowers is placed, by means of a quill, a small quantity of this poisoned mixture. This poison should be of about the following proportions: Cobalt, one ounce; molasses or honey, one-fourth pint; water, one pint." This practice is so well understood among tobacco growers that it is hardly worth detailed mention, except to state that experiments at the Louisiana experiment station and elsewhere have proved that it is effective as a palliative. At the experiment station just mentioned jimson weed was grown for this purpose, and the writer remembers a doleful complaint by the director of this station some years ago to the effect that his farming visitors interfered with the experiment, since their horror of weeds was so great that, in passing through his grounds, they pulled up the jimson weeds and spoiled his experiment.

Many years ago Townend Glover, the first entomologist of the Department, in mentioning this method of catching the moths of the horn worm, suggested the manufacture of artificial porcelain or tin jimson flowers, which would be perennial in the highest degree and could be poisoned year after year. The writer is not informed, however, as to whether this suggestion has ever been followed.

A sweetened preparation, poisoned with arsenic, however, has been tried in Maryland by Prof. W. G. Johnson The material was placed in wooden pails, perforated near the bottom and set in granite pans, into which the poisonous liquid was leached. These traps or decoys were set upon stakes about the field a little higher than the tops of the tobacco. Although the experiment appeared to be successful, Professor Johnson reserves his final conclusions until he has had an opportunity to make further tests another year.

Most tobacco growers have learned by experience the necessity of carefully removing the worms from the leaves after or during cutting and before they are carried into the barn, since otherwise they will continue to feed in the barn on the drying leaves. Where such care has not been exercised, the evaporation of bisulphide of carbon in the barn, in accordance with the directions and with the precautions which will be described under the head of remedies for the cigarette beetle,

will kill the worms before they can do further damage, and the quality of the tobacco, as we have proved by experiment, will not be injured in the least, the reverse being the case when the smoke from a damp wood fire is used, as it is sometimes for this purpose.

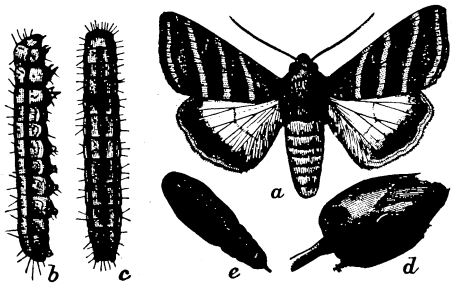

FIG. 7.—The true bud worm (*Heliothis rhexiæ*): *a*, adult moth; *b*, full-grown larva, from side; *c*, same, from above; *d*, seed pod bored into by larva; *e*, pupa—natural size (original).

THE BUD WORMS.

(*Heliothis rhexiæ* S. & A. and *Heliothis armiger* Hübn.)

Just as there are two distinct though very similar insects known as horn worms, so there are also two distinct and rather similar insects known as bud worms, which occur frequently together in the same field and work in a somewhat similar manner. We shall take the liberty of distinguishing between them by calling one the true bud worm and the other the false bud worm.

The true bud worm (*Heliothis rhexiæ*) occurs in the more southern portions of the tobacco-growing regions, but has not been noted in tobacco fields north of Maryland. The adult insect is a small, greenish moth, well illustrated in fig. 7. The larva or caterpillar of this moth, also characteristically shown in fig. 7, is nearly always found in the bud of the tobacco plant about the time the plant is ready to top. In some seasons they occur in large numbers and damage the tobacco considerably. In the early part of the season, as a general thing, but few of them are found, and in ordinary seasons they are not especially noticed during the early "worming" of the tobacco. In August they begin to be more abundant, and generally leave the plant about the end of the month, entering the ground, transforming to pupæ and issuing as moths toward the end of September. These dates are Virginia

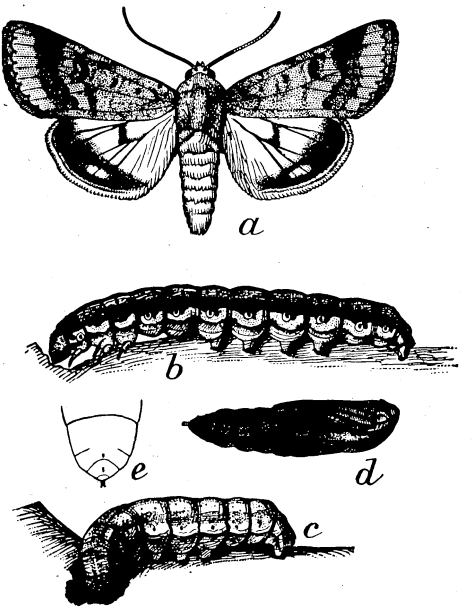

FIG. 8.—False bud worm or cotton boll worm (*Heliothis armiger*): *a*, adult moth; *b*, dark full-grown larva; *c*, light-colored full-grown larva; *d*, pupa—natural size (original).

dates, but hold reasonably well as far south as Mississippi. As just stated, the greatest damage done by this insect is by the August brood, when it enters the rolled-up leaves or bud of the plant. In September and October the next generation of caterpillars is found boring into the seed pod and occasionally into the flower stem. We have received the insect at various dates from July 10 to the end of August from Virginia, Georgia, Alabama, and Mississippi. The worst account of damage which has come to us was received in July, 1888, from Mr. J. S. Barnwell, of Darien, Ga., who said that in general this bud worm damaged his tobacco more than the horn worm. When young it occurred abundantly in the buds and ate so many holes through the young leaves as to render them unfit for wrappers.

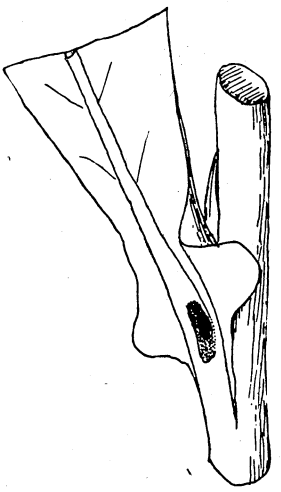

FIG. 9.—Work of full-grown false bud worm in flower stem—reduced (original.)

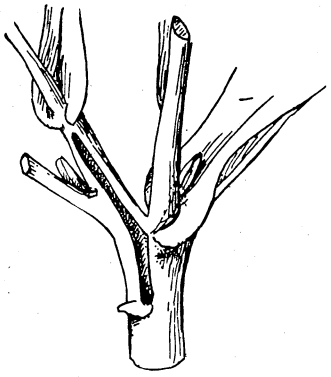

FIG. 10.—Work of young false bud worm—reduced (original).

The caterpillars of the last fall generation enter the ground and hibernate as pupæ. The insect has several other food plants aside from cotton, but its most abundant food in the South is the weed known as ground cherry (*Physalis viscosa*). It has been found on several solanaceous weeds, as well as upon cultivated geranium.

FIG. 11.—Work of false bud worm in seed pods—reduced (original).

The species which we have called the false bud worm (fig. 8) is the same caterpillar which, when occurring upon cotton, is called the "cotton boll worm;" upon tomato, the "tomato fruit worm," and upon corn, the "corn-ear worm." It is the larva of *Heliothis armiger*, a cosmopolitan species of varied food habits, and which, as its different popular names denote, has a destructive propensity for boring into anything like a pod. Fortunately, tobacco is not a preferred

food plant. The insect lives on corn until the ears are too hard for easy attack, and then transfers its attention to other plants. From this it results that it is usually only late in the season that the larvæ are found upon tobacco. Here it works much as does the true bud worm, boring into the seed pods and into the flower stalks, as indicated in figs. 9, 10, and 11, and also, more rarely, feeding upon the leaves. These remarks hold for Virginia. In Florida, however, according to Mr. Quaintance, the principal damage is done by these caterpillars during the early part of the year, when they do not have corn or cotton to feed upon. The eggs are deposited in the bud, and the larvæ do very serious harm by feeding on the young and as yet unfolded leaves. A large worm may quite devour a bud. In color and markings the false bud worm is one of the most variable of caterpillars. On tobacco the writer has found specimens of a uniform, light green color, without spot or stripe, and others the general effect of which was nearly black. Between these two extremes many variations occur. This insect, like the true bud worm, passes the winter in the pupa condition under the surface of the ground.

REMEDIES.

The arsenical spray recommended for the flea-beetle and for the horn worms will also be efficacious, to a certain degree, against the bud worms, but in Florida Mr. Quaintance has found it desirable to make a specific treatment for these insects, which, when they are very numerous, may be advisable, although it necessitates considerable trouble. He recommends sprinkling poisoned corn meal in the bud. He adds a half teaspoonful of Paris green to a quart of finely-ground corn meal, which is thoroughly mixed by stirring. He then makes a sprinkler of a baking-powder can, in the bottom of which numerous holes have been punched, so that when it is shaken the poisoned corn meal may be peppered over the bud. He advises that the poison should be frequently applied, and after heavy rains.

With these, as with other tobacco insects, there is much to be gained by clean culture, in keeping down the weeds on which the insects feed, and also by careful attention to corn and tomatoes which may be growing in the vicinity. Late fall plowing is efficacious against both species by breaking up the little earthen cells in which the pupæ are found under the ground, thus exposing them to the action of frosts.

THE NEW TOBACCO BUG, OR "SUCK-FLY."

(*Dicyphus minimus* Uhler.)

This insect is not only new as a tobacco enemy but is new to science, and was named and described by Professor Uhler in November, 1898. The specimens from which the description is drawn were received at the office of the Entomologist from Florida, but Professor Uhler had previously received specimens from Louisiana, Texas, Mississippi, and Alabama, with an account from the latter State that it feeds upon

tomatoes. It was first brought to the writer's attention in July, 1898, by Mr. T. A. Carroll, of Gainesville, Fla. Specimens which were received at that time were fed here upon tobacco through the remainder of the season. The eggs have not been found, but two generations developed between July and the killing frosts, on which date the bugs disappeared, hiding away in the full-grown condition for hibernation. The different stages of growth observed are shown in fig. 12. The species has been studied to better advantage in the field by Mr. Quaintance in Florida, who considers it a serious enemy of the crop,

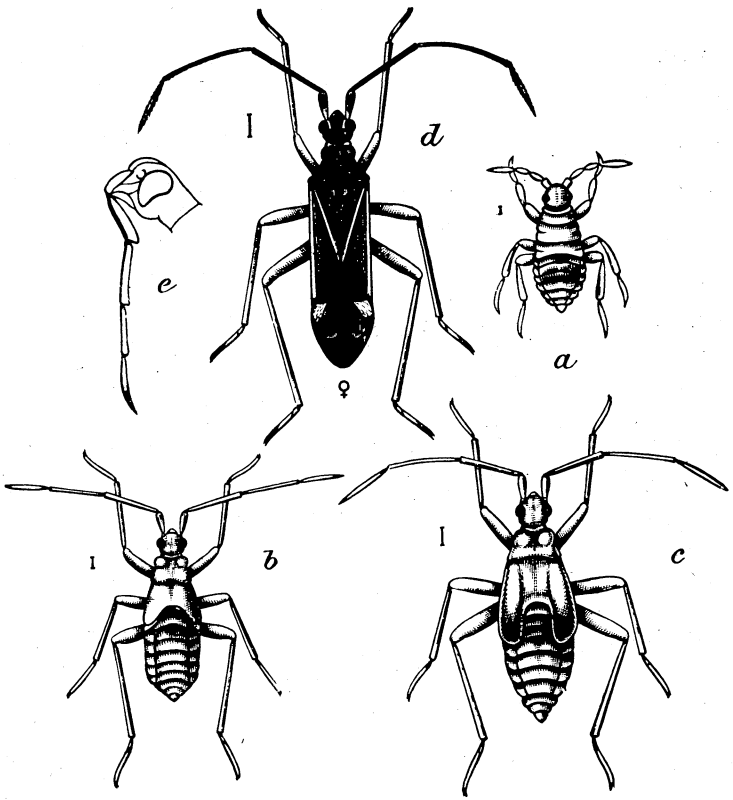

FIG. 12.—The "suck-fly" (*Dicyphus minimus*): *a*, newly hatched; *b*, second stage; *c*, nymph; *d*, adult; *e*, head and beak from side—enlarged (original).

and states that it has been known to growers in Columbia County for the past ten years. The first crop is generally not damaged to any serious extent, but the second crop and late tobacco are frequently quite destroyed. Mr. Quaintance also states that the insects make their appearance in injurious numbers during the first and second weeks in June, and that the full-grown bugs are first noticed in some restricted portion of the field, as on the plants in one corner, from which they gradually move over the field. They have been observed on neglected tobacco as late as November 22.

The insects damage the leaf by sucking the cell sap through their beaks. The infested leaf soon becomes yellowish in color and somewhat wilted, and the older leaves eventually split in places, so that they become very ragged. The immature specimens of the bug live on the underside of the leaves, but the adults live both above and below. The full-grown specimens are partial to shade, and may be observed feeding close to the margin of a shade thrown by an overhanging leaf. Experienced tobacco growers say that leaves which have been badly infested with the "suck-fly" are very difficult, if not impossible, to properly cure. Mr. Quaintance says that the eggs are deposited singly in the tissues of the leaf, and mainly in the smaller veinlets. He finds that the egg state lasts about four days, and that in Florida the entire life cycle of a given generation is only about fifteen days. He was unable to keep the adult insect alive in a breeding cage for more than six days, but we have kept them in Washington City for at least a month.

REMEDIES.

This, again, is an insect against which clean culture will be reasonably effective. A thorough cleaning up of the fields and burning of the trash in the autumn are measures which should be adopted when the insect is abundant. Actual test experiments with different insecticides were made by Mr. Quaintance, who found that a concentrated solution of nicotine, diluted with sixty parts of water, will kill a large proportion of the full-grown insects and many of the young. He advises that this spray be applied early in the morning, as at that time the insects are less active. Early set trap plants will probably be an advantage in concentrating the hibernating insects, so that they can be readily killed.

OTHER SUCKING BUGS.

Several true bugs, which damage the leaves by inserting their beaks and sucking the juices, causing a shriveling or drying of the leaf in the same way as the harlequin cabbage bug injures the leaves of the cabbage, are found in the tobacco fields. Several of these plant bugs are known indifferently to tobacco planters as "stink bugs," on account of the disagreeable odor which they give out. We have never known any of them to be a very serious factor in tobacco growing.

One of the commonest of these bugs in the more northern portions of the cotton belt is *Pœcilocystus diffusus* Uhler. This insect is found in all seasons of the year, and when very abundant the remedies recommended against the "suck-fly" may be used. The writer has found it very abundant and in all stages of growth in Virginia tobacco fields as late as November.

Another species is a green bug shown at fig. 13, and which is known scientifically as *Euschistus variolarius*. This is a species which was

found by Professor Garman wilting plants in an experimental plat of tobacco at the Kentucky Agricultural Experiment Station in the summer of 1896, and which is suspected to have done more or less damage over quite a wide extent of country that season.

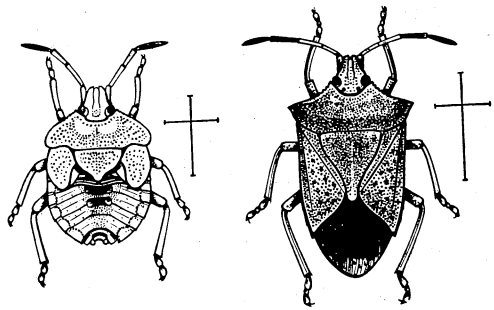

FIG. 13.—*Euschistus variolarius:* nymph at left; adult at right—enlarged (original).

An interesting little bug of the family Scutelleridæ, viz, *Corimelæna extensa* Uhl., has been found damaging native tobacco at Cedar Ranch, Ariz., by Prof. C. H. T. Townsend. It is reported to be the only member of its family which lives upon tobacco, and as Professor Townsend found it to be very abundant, it is probably an important future enemy to the tobacco crop, especially if tobacco culture increases in the Southwest.

THE TOBACCO LEAF-MINER, OR "SPLIT WORM."

(*Gelechia solanella* * Boisd.)

This insect, which is also comparatively new in this country as a tobacco insect, was first brought to the writer's attention as an enemy to this plant early in 1896 by Prof. Gerald McCarthy, formerly of the North Carolina experiment station. The adult insect is a minute, grayish moth, shown in fig. 14. Its eggs are laid upon the leaves, and the minute caterpillar bores between the surfaces of the leaf, making a flat mine, often of considerable size, with a gray discoloration visible from both sides of the leaf. Frequently there is a distortion when the mine occurs near a large vein, as shown in fig. 15. There are two or more generations in the course of the summer, and the insect is more noticeable in the autumn than at an earlier date. Down to the year 1898 the insect was known to occur as a tobacco insect in this country in North Carolina only, the exact locality not having been given to us by Professor McCarthy, nor did he mention it in the little account of the insect which was published in Bulletin No. 141, of the North

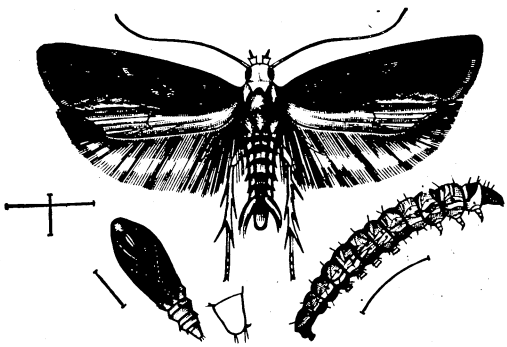

FIG. 14.—Tobacco split worm: adult moth above; larva below at right; pupa below at left, with side view of enlarged anal segment—all enlarged (original).

* Since the publication of the original article this insect has been found to be Zeller's *Gelechia operculella*, the type having been received from Texas.

Carolina Agricultural Experiment Station. During that year, however, Mr. Quaintance found the insect damaging tobacco in many localities in Florida, and the writer discovered it mining tobacco leaves in Pittsylvania County, Va. Specimens were also received from Mr. J. J. Wolfe, of Sandy Run, Lexington County, S. C., who stated that he was troubled the same season by this insect, which made its appearance early and increased its damage as the season advanced. The writer of this bulletin is indebted to Mr. Wolfe for the characteristic name of "split worm," by which he stated the insect was commonly known in his vicinity. He also stated that during that year it did more damage in his neighborhood than all other insects combined.

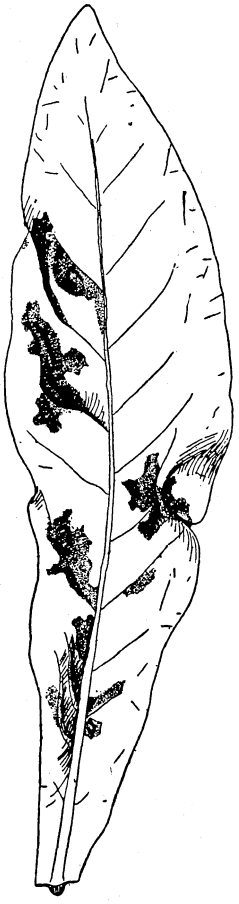

FIG. 15.—Work of split worm—reduced (original).

When Professor McCarthy first sent this insect to the Entomologist for identification, there was found to be some difficulty in ascertaining just what it was. On consulting a specialist in the group of insects to which this one belongs, it was decided to be *Gelechia piscipellis* of Zeller, an insect which has been reared in this country from the common horse nettle or ball nettle (*Solanum carolinense*), and under this name it was treated in the North Carolina bulletin by Mr. McCarthy, and in the Florida bulletin by Mr. Quaintance. A more careful study was given to the insect, however, during the preparation of this paper, and a great similarity was noticed between it and an insect which has been known as the potato tuber moth, an article on which was published in Insect Life (Vol. IV, p. 239 to 242), and which, after being recorded as damaging the tubers of the Irish potato in Algeria, Australia, and New Zealand, made its appearance in portions of California, also working in potato tubers; in fact, the only difference noted in the series reared from potato tubers from California and from tobacco leaves in North Carolina was a general difference in size. On comparison of the larvæ and pupæ from the two food plants these also were found to be identical.

To settle the matter beyond all question, a series of the moths from potato and tobacco were sent to Lord Walsingham, the English authority on the insects of this group, who confirmed our surmise as to their identity; and the tobacco leaf-miner must now be known as *Gelechia solanella* Boisduval. It transpires also that the same insect has been observed injuring tobacco in New South Wales "by burrowing

within the stems and larger branches;"[1] that it also occurs in tobacco in Algeria, and that it has also been described under the different name (*Gelechia tabacella* Ragonot) as injuring tobacco in Algeria. In this country it has also been observed by Professor McCarthy as mining in the leaves of horse nettle (*Solanum carolinense*) on the margins of tobacco fields, and is recorded by Mr. Quaintance as mining in the leaves of tomato and in the leaves and boring into the fruit of the eggplant. We have, therefore, as its food plants, potato, tobacco, horse nettle, tomato, and eggplant; and as its localities, eastern Australia, New Zealand, Algeria, California, Colorado, Florida, South Carolina, North Carolina, and Virginia.

In Florida the leaf-miners make their appearance about the last of May, and are said to occur as late as October. There are several generations each year. In southern Virginia the writer found full-grown larvæ in the lower leaves of tobacco plants about the margins of the fields as late as November 2. The insect was not known to tobacco growers in that vicinity, and when one prominent and exceptionally well-informed tobacco planter was shown these leaf blotches he said: "That is not the work of an insect, but is what we call 'wet weather rot,'" and appeared surprised when the writer pulled apart the two surfaces of the leaf and showed him the little worm. At that season of the year the little mining caterpillar was something over a quarter of an inch in length and of a dull greenish color, with darker head and thorax.

REMEDIES.

Professor Quaintance has shown that in Florida this leaf-miner, when feeding, does not pass its entire life in one place, but after eating for awhile it will gnaw to the outside, and then crawling around over the leaf, will finally enter the tissue again in a new place. From this habit of the insect, it at once becomes evident that it will be subject to destruction by an arsenical spray, just as are the caterpillars which uniformly feed externally upon the leaves. Moreover, from the fact that in Virginia and North Carolina it is frequently well on into July before the tobacco crop is planted out, the early generation of the insect must be passed in some other food plant. Where horse nettles are present in the vicinity of the fields the insects will feed in the leaves of this plant, and the second generation will attack the tobacco fields. The destruction of all horse nettles, then, about June 1, will be a practical measure which will reduce the numbers of the split worms in tobacco to a minimum.

Although this insect has not been found in the nightshade and the jimson weed, it is altogether likely that it will also attack these weeds, and their destruction, therefore, is equally to be recommended.

The insect doubtless passes the winter in the leaves as a larva or a pupa, and the advisability of destroying old, blotched leaves which

[1] A. S. Olliff, Agr. Gaz., N. S. W., September, 1892.

have no value is at once evident. Clean culture in this direction is advisable on other grounds, and is certainly desirable as a means of reducing the numbers of this species.

The partial synonymy furnished to the writer by Lord Walsingham is as follows:

Solanella, Bdv.

Gelechia terrella,[1] Wkr. Cat. Lp. Ins. B. M., XXX, 1024 (1864). *Bryotropha solanella* Bdv., J. B. Soc. Cent. Hort. 1874; Rag. Bull. Soc. Ent. Fr. 1875, XXXV-XXXVII. *Gelechia tabacella*, Rag. Bull. Soc. Ent. Fr. 1879, CXLVI-CXLVII. *Gelechia solanella*, Meyr. Pr. Lin. Soc. N. S. W., 112 (1879); N. Z. Jr. Sc., II, 590 (1885). *Lita tabacella*, Rag. Bull. Soc. Ent. Fr. 1885, CXI-CXII. *Gelechia solanella*, Meyr. Tr. N. Z. Inst., XVIII, 166-7 (1886). *Lita solanella* (Olliff), Agr. Gaz. N. S. W., II, 158-9 (1891).

CUTWORMS.

Tobacco is no less subject to the attacks of cutworms than are many other crops. Grown in seed beds, as it is, and set out in newly plowed fields in the summer, the plants are naturally attacked by the hungry worms, which for some days at least had existed in the soil deprived of food. It is a common experience with tobacco growers, as well as other agriculturists, that cutworms are always more numerous in fields left in fallow for a period before being planted to certain crops. There is a greater variety of vegetation in such fields, and the moths which lay the eggs which produce the cutworms are more apt to be attracted. Tobacco growers who have planted their fields to clover after the removal of the tobacco crop are also apt to find that there are plenty of cutworms present the following season. Those who plant winter grain, however, find that the following crop is less liable to damage by cutworms. This indicates the relative value of different cropping methods. It is a comparatively simple matter, however, to rid a field of cutworms before planting out the tobacco, and as a measure of safety this course may be followed to advantage. After the field is

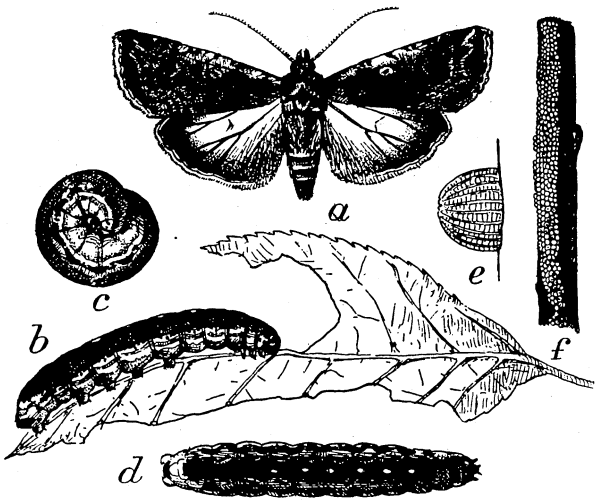

FIG. 16.—*Peridromia saucia: a*, adult; *b, c, d*, full-grown larvæ; *e, f*, eggs—all natural size except *e*, which is greatly enlarged (original).

[1] Oldest name but a homonym.

plowed and is bare of vegetation and ready for planting, if the tobacco grower will thoroughly spray a patch of grass or weeds with Paris green and water, and will then cut it and drop it in little bunches here and there throughout the tobacco field, he will find that the cutworms in the soil, in the absence of other food, will eat this cut poisoned vegetation and will be destroyed, so that the tobacco plants can be set out without fear of damage.

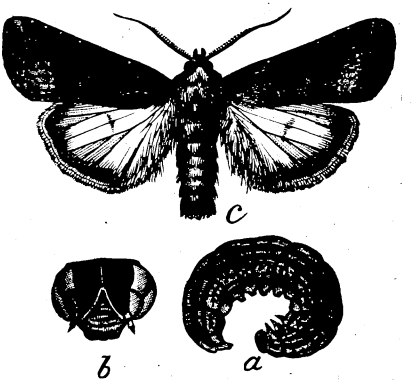

FIG. 17.—*Agrotis ypsilon*, one of the tobacco cutworms: *a*, larva; *b*, head of same; *c*, adult—natural size (original).

Without such preventive treatment (and especially when, as indicated above, the land has grown up with weeds, grass, and other wild vegetation) before the planting out of the tobacco crop, the result will frequently be the cutting down by the cutworms of a large proportion of the tobacco plants; and the writer has known of instances where more than one-half of the crop had to be replanted.

Some farmers, instead of a poisoned trap of green vegetation, prefer the so-called bran-arsenic mash, which originally came into use as a remedy against insects in California, where it was successfully used against the California devastating grasshopper. It was first tried against cutworms in California also successfully. In the East it has been used against cutworms affecting different crops, and with the greatest success in southern Virginia against the American locust or grasshopper. In the tobacco field it has also been successfully used against cutworms in Florida. The bait, or mash, is prepared by thoroughly mixing Paris green and bran at the rate of 1 pound of Paris green to 50 or 75 pounds of bran. Just before using, it should be moistened slightly with water and sweetened with molasses. The Florida custom is to put a small ring of the poisoned mixture around each newly set plant, or to place a teaspoonful at two or three different places. Cutworms prefer this poisoned mash even to green vegetation. It should be renewed frequently, and fowls or live stock should not be allowed access to it. Mr. Quaintance recommends that where seed beds are

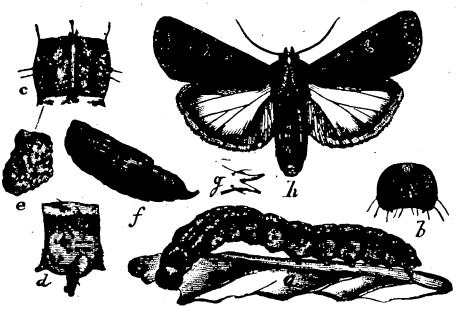

FIG. 18.—*Agrotis annexa*: *a*, larva; *f*, pupa; *h*, adult—natural size (*h*, original; others from Ann. Rept. U. S. Dept. Agr., 1894).

badly infested with cutworms the poisoned bran should be drilled along in various parts of the bed where it will be readily accessible to them. The bran-arsenic mash produces the best results when it is used as we have recommended for the poisoned-vegetation trap to rid the land of cutworms before the tobacco plants are transferred from seed bed to field. In this case the land is prepared beforehand, and a little of the mash is dropped in the drill near the place where the plant will be set. Prof. W. G. Johnson recommends that this should be done from three to five days before the plants are set out.

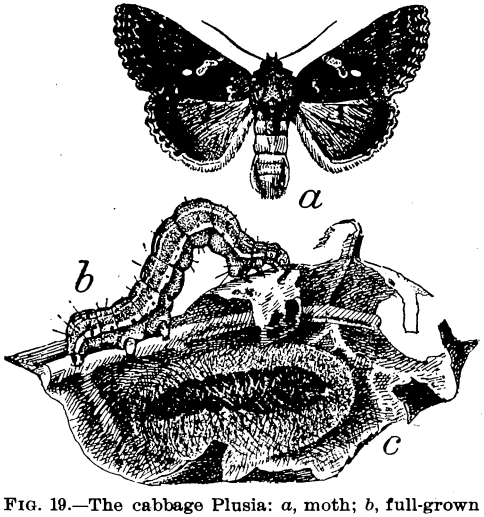

FIG. 19.—The cabbage Plusia: *a*, moth; *b*, full-grown larva; *c*, pupa, with its cocoon—natural size (original).

A number of different species of cutworms may be concerned in this damage, and some of the characteristic forms which have actually been found in the tobacco field are illustrated in figs. 16, 17, and 18.

OTHER TOBACCO LEAF-FEEDERS.

Several insects of less economic importance than those which we have already mentioned are occasionally found feeding upon the leaves of the plant.

The so-called cabbage Plusia (*Plusia brassicæ* Riley).—This insect (fig. 19), which occurs in most parts of the United States and has a number of different food plants, has been found in tobacco fields in Maryland, feeding upon the leaves, by Mr. F. C. Pratt, of the Division of Entomology, although not in sufficient numbers to give it a high rank as a tobacco insect. It is one of the species which is readily destroyed by the arsenical spray.

Mamestra legitima Grote.—This insect (fig. 20), which is allied to the cutworms, feeds exposed upon the foliage of different plants. Its larva is a very handsome caterpillar, bright yellow in color, with velvety-black longitudinal lines. It has never been recorded as a tobacco insect, but was found rather abundantly by the writer in tobacco fields in southern Virginia upon the leaves, which, in some cases, were badly ragged. This insect can also be easily destroyed by the arsenical spray.

The tobacco thrips (*Thrips tabaci* Lindeman).—This minute insect, which sometimes does considerable damage to onions and which has been popularly known in this country as the "onion thrips," was originally described, in 1888, by Professor Lindeman, of Russia, as an

enemy of tobacco in Bessarabia. It occurs upon many plants in this country, but has never been found upon tobacco, although in southern Russia it at one time caused much damage to the leaves, puncturing them and causing them to wilt. As this insect, occurring in this country as it does from the Atlantic to the Pacific, may at any time be found upon tobacco, it is worthy of mention and of an illustration in this connection. It is shown at fig. 21.

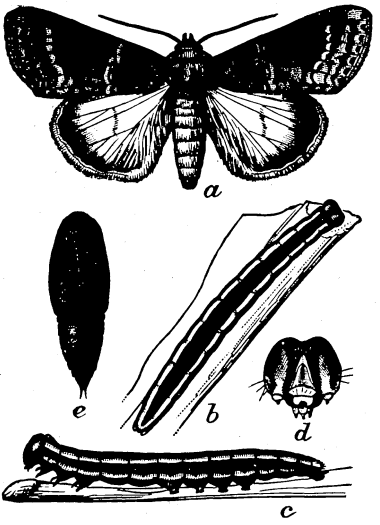

FIG. 20.—*Mamestra legitima: a*, adult; *b*, larva from above; *c*, same from side; *d*, head of same from front; *e*, pupa—all natural size except *d*, which is enlarged (original).

The "white fly" of tobacco (*Aleyrodes tabaci* Gennadius).—One of the insects especially noticeable in Europe is a minute form which looks like a small scale insect on the under side of the leaf. Its damage to tobacco in Greece was demonstrated by Professor Gennadius in 1889. A closely allied or identical species occurs upon tomato in this country, but European specimens from tobacco have not been compared with our tomato species, so that we can not speak positively as to their identity. The tomato species is, however, liable to be found upon tobacco.

Tree crickets (*Oecanthus fasciatus*).—Young tree crickets are occasionally found upon tobacco, eating the leaves to some slight extent. They do no especial damage, but are worth mentioning in this connection. The greatest damage done by tree crickets is occasioned by the punctures in the stems of plants like raspberry and blackberry, which are made by the females in laying their eggs. So far as known, they have not been observed to puncture tobacco for this purpose. In portions of Maryland these little insects are known as "chatteracks," presumably from the song of the male.

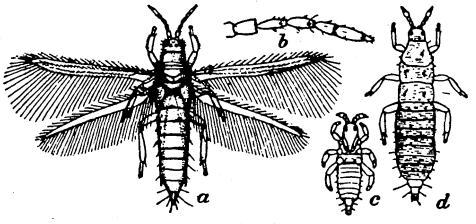

FIG. 21.—*Thrips tabaci: a*, adult; *b*, antenna of same; *c*, young larva; *d*, full grown larva—enlarged (original).

The mealy bug (*Dactylopius citri* Risso).—In the course of greenhouse observations on tobacco plants at Washington City it has been found that the common mealy bug thrives and multiplies alarmingly upon tobacco plants. Since this mealy bug is an outdoor pest of many plants in the South, it seems from this experience that it has

only to be brought into the immediate vicinity of a tobacco field to spread upon the crop, and under favorable conditions it may occasionally do considerable damage.

Plant lice.—Several species of plant lice are known in Europe to occur occasionally upon tobacco, and several of our American species which affect solanaceous plants are liable at any time to be found upon tobacco. As a matter of fact, however, we have never known any especial damage to be done to tobacco by these insects. Late in the autumn of the present year the terminal leaves of the tobacco plants growing in the experimental plats of the Division of Entomology became covered with a plant louse known as *Nectarophora tabaci* Pergande. This species has been found by its describer, Mr. Pergande, of the Division, during the last two years upon the leaves of young pear trees on the grounds of the Department of Agriculture, and also upon the leaves of apple, Rumex, Leucanthemum, and Forsythia, as well as tomato and eggplant. During the summer of 1898 the same species was received from Dr. F. P. Phelps, of Mount Holly, Md., with the information that 5 acres of tomato plants were covered with countless millions of these lice. The writer would not be at all surprised if in the near future considerable damage to tobacco by this species should be reported.

FIG. 22.—*Limax campestris*—natural size (after Binney).

The twelve-spotted Diabrotica, or "corn root-worm" (*Diabrotica 12-punctata*).—In Kentucky, according to Professor Garman, this small, greenish beetle, marked with twelve black spots, which is so common on cucumbers, squashes, melons, and other cucurbitaceous plants, is often found on tobacco leaves, eating small round holes. Its larvæ feed on the roots of corn, and the beetle is only a casual visitor of the tobacco field. It can not be considered a dangerous insect by the tobacco grower.

Slugs (*Limax campestris* Binney, and allied species).—Damage is occasionally done to young tobacco plants in seed beds by slugs. Specimens were received last summer from Dr. H. T. Fernald, the State zoologist of Pennsylvania, which he said had very seriously damaged some of the tobacco beds by eating the young leaves. These specimens were submitted to Dr. W. H. Dall, of the Smithsonian Institution, who said that they were young and badly contracted, but probably belonged to the species known as *Limax campestris* Binney, which is shown by fig. 22.

THE CIGARETTE BEETLE.

(*Lasioderma serricorne* Fabr.)

Of the insects injurious to cured tobacco none approach, in economic importance, the species which has become known as the cigarette beetle. The name "cigarette beetle" is more or less of a misnomer, since the insect not only feeds in all kinds of dried tobacco, and even in snuff, but also in many other substances, such as rhubarb, ginger,

cayenne pepper, ergot, turmeric, yeast cakes, rice, figs, prepared fish food, and dried plants prepared for the herbarium.

Working as it does in all kinds of cured tobacco and living in this substance during all stages of its existence, it damages cigarettes and cigars principally by boring out of them, making round holes in the wrappers so that they will not draw (fig. 23). Leaf tobacco is injured for wrapping purposes by being punctured with holes made both by the larvæ and the beetles, and fillers and fine cut are injured by the reduction of their substance by the actual amount consumed by the larvæ. The adulteration of fine cut by the bodies of the insects and by their excrement is also a kind of damage, though an entomological acquaintance of the writer insists that he buys infested short cut by preference, both because he can get it cheaper and because the bodies of the insects impart a distinct and not disagreeable flavor to the tobacco. He admits, however, that it is a cultivated taste.

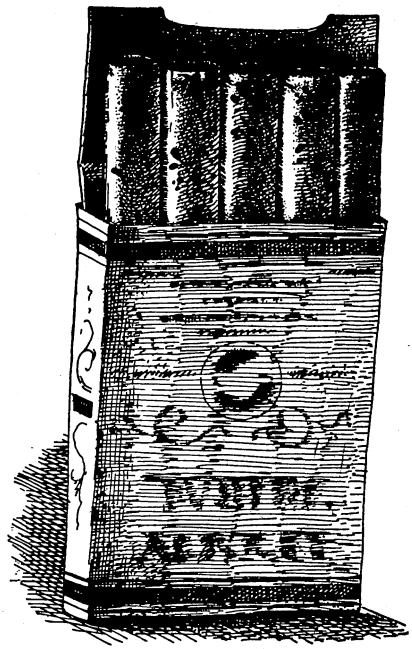

FIG. 23.—Work of cigarette beetle—reduced one third (original).

The cigarette beetle is practically cosmopolitan, and probably occurs in most tobacco factories in the Southern States, as well as in most wholesale drug stores. In the far South this insect multiplies rapidly throughout the greater part of the year, and its development is practically continuous in artificially warmed factories farther north. Observations upon the life history of the species were made by Prof. George F. Atkinson some years ago, when he was connected with the North Carolina Agricultural Experiment Station, and more recently by Mr. Chittenden, of the Division of Entomology. It seems tolerably certain that there are two generations produced each year in the District of Columbia. Professor Atkinson says that he has seen the beetles in copulation in January at Chapel Hill, N. C., but Mr. Chittenden has never seen the beetles later than November or earlier than May. It passes the coldest of the winter months in the larva state. In artificially warmed buildings the insect is apt to be present in all stages at almost any time of the year. Professor Atkinson observed that the larvæ hatch in eleven days from the time of egg laying, and that they remain as larvæ from sixty to seventy days. The larva (fig. 24) when full grown spins a fairly compact cocoon of a silky substance covered with bits of whatever substance the insect is breeding in. In this cocoon it soon transforms to a pupa and the adult beetles emerge

later. Mr. Chittenden has found that in a warm room the entire life round may be undergone in forty-seven days. These insects were reared in a dry yeast cake, however, and not in tobacco.

It is only within comparatively recent years that the cigarette beetle has become at all serious to tobacco manufacturers in this country, but it has been increasing and spreading of late, and at the present time it is found not only in many factories, but also in warehouses, tobacco barns, and retail establishments. The writer knows of one little shop into which it was accidentally introduced in some plug tobacco. It increased, entered the show cases, and ruined a large number of high-priced cigars and cigarettes. The shopkeeper was in despair, but finally, at the advice of the writer, submitted his entire stock to fumigation with bisulphide of carbon, and thus completely rid his establishment of the beetle.

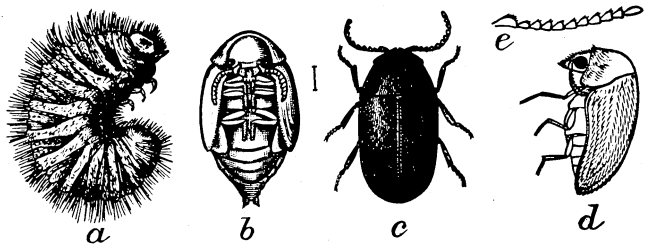

FIG. 24.—The cigarette beetle: *a*, larva; *b*, pupa; *c*, adult; *d*, side view of adult; *e*, antenna—all greatly enlarged, *e* still more enlarged (re-engraved from Chittenden's illustration).

REMEDIES.

With a small establishment like the one just mentioned, it is a comparatively simple matter to destroy the insect by means of the fumes of bisulphide of carbon. The place was clean and well-swept and dusted, and all that was necessary was to have a tight case (a show case was used) and the entire stock of tobaccos, cigarettes, and cigars was placed in the case in installments, and a saucerful of bisulphide of carbon was evaporated over night. In the morning the contents of the case were removed, the store was aired, and the next night another lot was fumigated. For some time after this experience the shopkeeper in question used the same case as a quarantine box, and put all of the tobacco which he bought through the fumigating process before he placed it on his shelves. Gradually, however, his vigilance was relaxed, and he has since had no experience with the cigarette beetle.

In a large factory, however, the case is, of course, very complicated. The average factory is not a clean place. It is frequently an old building, roughly built, with innumerable cracks in the floors and walls, which, in the course of years, have become filled with tobacco dust and fragments. Even the crevices about the windows are filled with comminuted tobacco. Frequently large stocks of tobacco are kept on hand a long time. When the cigarette beetle has once obtained a foothold in such an establishment, it is a matter of considerable time, expense, and energy to get rid of it, and at the same time it is as much as the reputation of such a factory is worth to allow goods to go out containing any specimens of the insect in any form.

There is an unfortunate and, the writer believes, wholly unjustified prejudice against steaming tobacco. Experiments carried on by Professor Atkinson in 1885 or 1886 showed that proper steaming will destroy this insect in all of its different stages, and the practical experience of several tobacco manufacturers, whose establishments have been visited by the writer, has indicated the same thing. With this knowledge, therefore, barring prejudice, there is no reason why a tobacco manufacturer should ever put out any infested tobacco. It becomes important, however, to entirely rid his establishment of the insect, and here nothing but heroic measures will avail. Taking a room at a time, the floor and walls must be thoroughly cleaned, the walls whitewashed, and all beams and floor cracks subjected either to steaming or to a thorough spraying with kerosene or benzine, great care being taken to avoid fire in case the latter substance is used. Benzine is preferable to kerosene on account of its greater volatility, in that the establishment can be more readily rid of the odor, but it is more dangerous on account of its higher inflammability. The beetles are quite inclined to fly to the light and to settle about the windows; therefore the window cracks should be especially looked after. With such a thorough treatment as this, taking room after room, the writer feels sure that the insect can be exterminated in almost any tobacco factory.

Where it is not desired to use steam, experience has shown that, as above indicated, bisulphide of carbon may be used to good advantage. With leaf tobacco such a fumigation must be very thorough to kill the insects embedded in the mass of the leaves. Experiments made in the writer's office with hydrocyanic-acid gas show that it is not to be compared in efficiency with bisulphide of carbon for this work. While the bisulphide treatment is preferably made in a tight bin, it may also be carried on in a tight room. In either case 1 ounce of the liquid should be evaporated for every 62½ cubic feet of space, or 1 pound for every 1,000 cubic feet. Every precaution should be taken, however, to see that the room is perfectly tight, and also that no fire is allowed to enter the room until after it has been most thoroughly aired. The vapor of bisulphide of carbon in confinement is inflammable and explosive.

In cigar and cigarette factories much that we have just said will be applicable. The tobacco, before use, should be steamed, if possible. Loose tobacco should not be left exposed at night. Boxes or piles of cigarettes or cigars, after being made, should be covered very tightly to prevent the access of the beetles. These precautions are more important during May and late August and September than at other times of the year, since at these periods the adult insects are flying about in great numbers. This statement holds for Virginia and Maryland, but for Key West and other Southern points the dates will have to be altered.

As a matter of interest, it may be said that there is a little four-winged fly which is parasitic on the cigarette beetle, laying its eggs in the larva of the beetle. This parasite is known scientifically as *Catolaccus anthonomi* Ashmead, and has been found in several

tobacco factories. It is doubtful, however, whether by its work it will ever rid an establishment of the beetle, but it undoubtedly helps to prevent rapid multiplication, and consequent great damage.

OTHER INSECTS INJURING DRIED TOBACCO.

There are several beetles which occasionally affect tobacco after the leaves are dried, in much the same manner as does the cigarette beetle, but none of them, as we have said, approximate in importance the latter insect. The so-called drug-store beetle (*Sitodrepa panicea*, fig. 25), an insect which has an enormous range of food, and occurs upon very many articles found on the shelves of drug stores, whence its popular name, will also breed successfully in tobacco, although we can not say that this substance is its preferred food. No cases have been brought to our attention of any serious damage to tobacco by this species. The ordinary rice weevil (*Calandra oryza*), another insect which feeds upon various stored products, has also been found breeding in tobacco, although its importance as a tobacco insect does

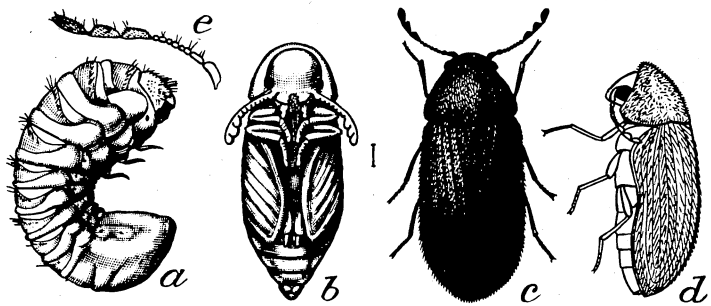

FIG. 25.—The drug-store beetle: *a*, larva; *b*, pupa; *c*, adult; *d*, adult from side; *e*, antenna—all greatly enlarged, *e* still more enlarged (reengraved from Chittenden's illustration).

not exceed that of the drug-store beetle, if indeed it equals it. Another insect which, though not at all a tobacco insect, became, some years ago, the cause of a curious litigation regarding the rejection of a large cargo of tobacco from this country by the French Government, is the so-called leather beetle (*Dermestes vulpinus*). The tobacco in question, in numerous hogsheads, was received in France, and upon examination it was found to have been perforated by numbers of the larvæ of this latter beetle, which had burrowed into the tobacco for a considerable distance and transformed to pupæ and later into beetles. The entire cargo was rejected by the French Government and returned to America, and the litigation which ensued was through the endeavor to place the responsibility for the entrance of the insect upon either the shippers or the carriers. It was shown that the tobacco must, at some period of its journey, have been stored in close proximity to bales of hides affected by this insect. The larva of the Dermestes, instinctively on reaching full growth, crawls away from its original habitat and bores into any near-by substance to find a protected spot for pupation. In this case the larvæ were

attracted by the cracks in the tobacco hogsheads, and not deterred by the pungent character of the contents of the hogsheads, they bored their way in, searching for a secure place to transform.

FOREIGN TOBACCO INSECTS WHICH HAVE NOT YET REACHED THE UNITED STATES.

In a previous paragraph we have mentioned incidentally the little scale-like insect known as *Aleyrodes tabaci* as one which has probably not made its appearance in American tobacco fields. Professor Targioni-Tozzetti, the Italian writer, to whose work reference is made in the first page of this paper, has listed 144 species of insects found in tobacco fields of Europe and adjoining countries, the great majority of which, however, are not important enemies of this crop and most of which are never likely to be brought to this country. There are in south Europe several distinctive cutworms which injure the crop in the same way as do allied forms in the United States; several grasshoppers, which feed upon the leaves of the plant, and several caterpillars which do occasionally more or less damage in the same way as do the leaf-feeding caterpillars which we have incidentally mentioned. In south Russia (Bessarabia) there is a tenebrionid beetle (*Opatrum intermedium*) which injures tobacco by attacking the stems underground. There are several plant bugs, several species of plant lice, wireworms, and other forms of greater or less importance which are recorded by the writer, but, on the whole, probably none of them are worthy of extended mention in this bulletin.

CONCLUSIONS.

REMEDIES IN GENERAL.

Upon looking over the whole ground, it seems to the writer that the tobacco crop is not a difficult one to protect from insects. It has not so many insect enemies as many other important crops, and the method of cropping is itself unfavorable to the increase of insects and favorable to their ready treatment. This is especially true of all portions of the country north of Florida.

In the seed beds there is in general no great danger of insect damage, but if insects should obtain a foothold most of them can be readily and safely treated by means of the arsenical spray.

After the plowing of a field into which plants are to be set attention should be paid to ridding the soil of cutworms. This can be done safely and easily by means of the poison-trap crop or the bran-arsenic mash mentioned in detail under the head "Cutworms." Where either of these remedies is used it is really a matter of indifference from the insect standpoint whether the land has been left fallow or whether clover or small grain has been grown. The planter can really follow just which course he thinks is best for his land without reference to cutworms, whereas without this treatment, as previously stated, fallow land or land planted to clover is apt to be full of worms, and the tobacco crop will have to be in part replanted.

At this time, or preferably earlier, it is important that the solanaceous weeds in the immediate vicinity of the field, and particularly the nightshade (*Solanum nigrum*), the horse nettle or bull nettle (*Solanum carolinense*), and the jimson weed (*Datura stramonium*), should be cut down, with the exception of a few marked clumps. These clumps will act as traps for nearly all of the tobacco insects. Practically all of the tobacco insects in the vicinity will be attracted to them and can be readily and economically treated with heavy doses of Paris green for the leaf-feeding species and with a spray of kerosene and water for the sucking bugs. Large numbers of these insects can be easily killed in this way, greatly to the protection of the young tobacco plants when they are set out.

During the growing season of the plants in the field there can be no doubt of the availability and usefulness of the arsenical spray. When used with reasonable care there can be no possible danger, as has been shown by careful experimental work and by chemical analysis of sprayed plants. Poison distributers, both for dry and liquid poison, are on the market, and the process is not an expensive one. It is used already by many practical growers, and it seems to the writer that the man who does not adopt it in time of necessity is behind the times.

After the crop has been cut the stubs of the plants and many leaves will be left. Moreover, in a warm autumn there will be considerable suckering. All of the tobacco insects left in the field which can by any possibility reach this sparse remaining tobacco vegetation will do so. Most of the horn worms, it is true, have gone into the ground and transformed into pupæ, but cutworms, budworms, leaf-feeding caterpillars, the last generation of split worms, all of the sucking bugs and the flea-beetles, during the warm, sunny, autumn days which precede the first killing frost will rely upon these remaining leaves and suckers for food. This is apt to be just the time when the tobacco planter pays no attention to the insect question, since his crop is gathered, but it is nevertheless just the time when he has his tobacco insects more or less concentrated, and upon worthless vegetation, which he can treat with heavy doses of arsenical poisons or even with pure kerosene without fear of loss. There can be no doubt that a little insecticide work at this time of the year will so greatly reduce the number of the insect enemies of the crop that the benefit will be felt in a marked degree the following season. The expense of such treatment would be very slight. A single individual in a day could cover a very large field.

Two of the points just mentioned, namely, the use of solanaceous weeds as traps in the spring and the treatment of mutilated plants and suckers in the fall, have not previously been mentioned in any article upon tobacco insects as far as the writer is aware. He believes that both suggestions are eminently practical, and that by their adoption an enterprising tobacco planter can reduce insect damage to a minimum.

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